<u>Office Action</u>

The Office rejected Claims 1-8 and 10-15 under 35 U.S.C. § 101 as being directed to non-statutory subject matter.

The Office rejected Claim 10 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

<u>35 U.S.C. § 101 Rejection of Claims 1-8 and 10-15</u>

The Office rejected Claims 1-8 and 10-15 under 35 U.S.C. § 101 as being directed to non-statutory subject matter. Applicants respectfully traverse this rejection.

The Office asserted that the preamble "merely sets forth the intended use or field of use of predicting a change in the economy" and that certain of the steps were "necessary antecedent steps to performance of the mathematical operation or determination of new values." *See* Office Action, item 2, paragraph 2. Applicants respectfully traverse.

The preambles of Claims 1 and 10 set forth what the steps accomplish: prediction of a change in an economy. Applicants have amended Claim 10 to make more clear the relationship between the preamble and the steps of the method. Applicants submit that the steps relating to representing decision makers, initializing the internal state of each agent, and generating and routing messages are **not** necessary antecedent steps; in contrast, they are **necessary steps** in Applicants' novel process that represents complex economic interactions by a **specific type of model**, and predicts changes in the economy by using the model. Accordingly, Claims 1 and 10 recite steps in a specific process that provides a new capability for predicting a change in an economy.

A new capability for predicting a change in an economy is a practical application in the technological arts. Processes limited to practical applications in the technological arts, even if implemented on a computer, are statutory subject matter. "For such subject matter to be statutory, the claimed process must be limited to a practical application of the abstract idea or mathematical algorithm in the technological arts." *See* MPEP § 2106, Section IV.B.2(b)ii). Applicants submit that Claims 1-8 and 10-15 are limited to a practical application in the

technological arts: the **prediction of a change in an economy by processing a specific type of model thereof.**

Claims 2, 5, and 10 are further limited to use on a multiprocessor computer. "A computer-related invention is within the technological arts. A practical application of a computer-related invention is statutory subject matter." *See* MPEP § 2106, Section II.A.

For a 35 U.S.C. § 101 rejection based on lack of limitation to a practical application, the Office has the burden to establish a *prima facie* case that the claimed invention taken as whole is directed to the manipulation of abstract ideas devoid of any limitation to a practical application. *See* MPEP § 2106, Section IV.B.2(e). Applicants submit that such a *prima facie* case has not been made because the claims in this application are limited to a practical application in the technological arts: predicting a change in an economy. Applicants' claimed invention of a method and apparatus for predicting a change in an economy is not a data structure per se, nor is it a computer program per se, nor is it non-functional descriptive material (e.g., music, literary works, mere data) per se, nor it is a naturally occurring phenomenon. *See* MPEP § 2106, Table A-2. Original claims are directed to a method with steps to be performed. The claims do not merely manipulate an abstract idea or perform a purely mathematical algorithm devoid of any limitation to a practical application. None of the claims recite an algorithm; the claims recite functional steps such as: representing, initializing, receiving, generating, routing, determining, and outputting. Accordingly, the claims are not directed to the manipulation of abstract ideas devoid of any limitation to a practical application.

Further, the application of Applicants' invention has **practical utility** in the technological arts. An economy can be a monetary economic system or can be a non-monetary economy, with practical applications in each area. For example, there is "real-world" value in applying Applicants' invention to predict economic vulnerability to variable economic influences. In addition, a non-monetary economy can include system capabilities, options, decision rules for strategy selection, and communications between decision makers. There is "real-world" value in applying Applicants' invention to a non-monetary economy (for example, a military confrontation with military capabilities, rules of engagement, campaign strategies, and battlefield communications). Applicants' invention can be applied to a hypothetical system to predict experimental outcomes (i.e., changes in an economy) by simulating complex

interactions, decision rules, and options, which cannot be adequately described by closed-form, analytic equations, and which may have no historical data from which to apply traditional regression and forecasting techniques. Applicants' invention thus provides a **useful tool** for solving difficult problems, and the claims are limited to application on these difficult problems.

Original Claims 2, 5, and 10 are further limited to a method using a **specific machine**, namely a multiple-processor computer, and steps involving specific control of the machine. *See* Specification, page 5, line 25. Applicants submit that controlling a specific machine to solve practical problems is a practical application in the technological arts.

Applicants' Invention is Limited to a Practical Application that is Useful

Applicants' invention is limited to a practical application: predicting a change in an economy by processing a specific type of model thereof. The present invention acts with a model of an economy -- a representation of real objects and relationships between objects using simulated actors and entities -- to provide useful, concrete, and tangible results. The present invention predicts behavior of models too complex to represent without the present invention, which can use a multiprocessor computer and simulate agent learning under incomplete data. *See* Applicants' Claims and Leijonhufvud, Section II, lines 74-76. Predicting behavior for a real system is **useful,** for example: to test system alternatives; to measure anticipated performance or system changes; to assess design; to analyze procedures and system performance; to determine system drivers by testing the sensitivity of simulation results to changes in input data; and to forecast and to aid in planning future developments. *See* Pritsker and Pegden, Introduction to Simulation and SLAM, Chapter 1, pages 1-15, 1979.

Applicant's invention models a real thing, an economy with specifically-defined decision makers and interrelationships between those decision makers. An economy, and a model of an economy, are specific, technological things -- not abstract ideas. Microanalytic simulation process models applied at the macro-level, for example to a real economy as in Applicants' invention, have not been done because they require massive amounts of computer processing capability, such as a multiprocessing computer having the capability to perform tasks in parallel. *See* Sandia National Laboratories, New Microanalytic Model Simulates U.S. Economy, SAND96-0249.

As discussed in Applicants' specification, other approaches exist to address this practical problem of modeling an economy, but they rely on regression analysis and aggregate macro-data for economic forecasting parameters, which loses the details of micro-level behavior and limits the model to behavior for which there exists historical data. *See* Bennett, page 1, paragraph 1, and page 4, lines 15-25. Applicant's invention models each agent's behavior at a micro-level (Claims 1-9 and 10-15) and can use learning techniques (Claims 3, 4, 6-8, 11-15) to adapt agent behavior according to changing conditions in an economy and past experience. The claims are limited to this practical application.

Applicants' invention is a tool with a specific use -- for predicting a change in an economy -- in the technological arts, and teaches a method for problems that are too complex to solve analytically. Computer simulation is the problem-solving process of predicting the future state of a real system by studying a computer model of the real system. Simulations can be performed to obtain predictive information that would be costly or impractical to obtain with the real system. Ultimately, information gained from the computer simulation contributes to decisions about the real system modeled by the simulation. *See* Widman et al., Artificial Intelligence, Simulation & Modeling, pages 15-16, 1989. Computer modeling of complex phenomena is recognized as a practical application. *See, e.g., Gardner et al.*, U.S. Patent 5,754,447 (1998).

Simulation models are different from mathematical (analytic or closed-form) models -- simulation models predict the changes in the states of the model of the system by focusing on/ modeling the behavior of individual components of the real-world system. Only rarely can complex real-world systems be adequately described by closed-form, analytic equations. *See* Widman et al. In macroeconomics, analytical methods are limited and do not allow decision-making with incomplete knowledge or with adaptive processes; more complex systems can only be investigated through computer simulations. *See* Leijonhufvud, Section II, lines 4-14 and lines 74-76. A method for predicting the behavior of models that are too complex to solve analytically is a practical application in the technological arts.

The claims are further examined separately to show compliance with 35 U.S.C. § 101.

Claim 1, limited to the practical application of predicting a change in an economy, is limited to a practical application in the technological arts, and accordingly is statutory subject matter. *See* MPEP § 2106, Section IV.B.2(b)ii).

The invention of Claim 1 is limited to the practical application of predicting behavior of a specific model. Claim 1 does not merely manipulate an abstract idea or solve a purely mathematical problem without any limitation to a practical application. *See* MPEP 2100, Section IV.B.2(c) and Chart A-2. Claim 1 does not recite a mathematical algorithm. As discussed above, a method of predicting a change in an economy using a simulation model is different from a mathematical or analytic model. Simulation models have a practical application in that they capture changes in the system by focusing on the behavior of individual components of the real-world system. Applicants' invention is a practical application that is especially useful; it can predict a change in a complex real-world system that cannot adequately be described by closed-form, analytic equations. *See* Leijonhufvud, Section II, lines 4-14, and Widman et al. Applicants teach a method for problems that are too complex to solve, and Claim 1 recites a method for solving. Claim 1, limited to the practical application of predicting behavior of a model of an economy -- a practical application that is especially useful for simulation models of complex real-world systems -- is statutory subject matter complying with 35 U.S.C. § 101. Applicants submit that Claim 1 is in condition for allowance.

Claims 2-8 and 11-15 depend from and further define Claim 1. Applicants submit that Claims 2-8 and 11-15 also recite statutory subject matter and are also in condition for allowance.

Claim 2 is Limited to a Practical Application, like Claim 1, Practiced on a Specific Type of Computer

Claim 2, depending from Claim1, is limited to the practical application of predicting a change in an economy. The method of Claim 2 is further limited to practice on a computer with multiple processors. As discussed for Claim 1, a method of predicting a change in an economy using a simulation model is a practical application, different from a mathematical or analytic model. Claim 2 does not merely manipulate an abstract idea or solve a purely mathematical problem devoid of any limitation to a practical application.

Applicants' method practiced on a computer is further limited to a practical application. Claim 2 recites a **method using a specific machine** -- namely a multiple-processor computer -- to predict a change in an economy. *See* Specification, page 5, line 25. "A practical application of a computer-related invention is statutory subject matter." *See* MPEP § 2106, Section II.A.

Claim 2 is limited to a practical application of predicting a change in a real-world economy, further limited to practice on a specific computer with multiple processors, and accordingly is statutory subject matter complying with 35 U.S.C. § 101. Applicants submit that Claim 2 is in condition for allowance.

Claim 5 is Limited to a Practical Application on a Computer with Interprocessor Communication

Claim 5 depends from and further defines the invention of Claim 2. Claim 5 is further limited to practice on a computer with interprocessor communication facility for routing messages and recites specific steps controlling the computer's operation. As discussed for Claim 1, a method of predicting a change in an economy using a simulation model is a practical application, different from a mathematical of analytic model. Claim 5 does not merely manipulate an abstract idea or solve a purely mathematical problem devoid of any limitation to a practical application. Claim 5 is limited to a practical application of predicting a change in an economy, further limited by specific steps controlling the computer's hardware resources. *See* Specification, page 5, line 25; and page 6, lines 5-8.

Claim 5 is limited to a practical application of predicting a change in a real-world economy, reciting specific steps for controlling the computer, and is statutory subject matter complying with 35 U.S.C. § 101. Accordingly, Applicants submit that Claim 5 is in condition for allowance.

Claim 10 is Limited to a Practical Application that uses a Multiprocessor Computer

Claim 10 is an independent claim. Claim 10, like Claim 1, is limited to a method of predicting a change in an economy using a simulation model, and is a practical application, different from a mathematical or analytic model. Like Claim 2, Claim is further limited to practice on a multiprocessor computer and recites a **method using a specific machine** -- namely a multiple-

processor computer, described in the specification as having the capability to perform processing in parallel -- to predict a change in an economy. Claim 10 does not merely manipulate an abstract idea or solve a purely mathematical problem devoid of any limitation to a practical application. Claim 10 is limited to a practical application of predicting a change in an economy, further limited by use of a multiprocessor computer. *See* Specification, page 5, line 25.

Claim 10 is limited to a practical application of predicting a change in an economy, further limited to use on a multiprocessor computer, and is statutory subject matter complying with 35 U.S.C. § 101. Accordingly, Applicants submit that Claim 10 is in condition for allowance.

35 U.S.C. § 112 Rejection of Claim 10

The Office rejected Claim 10 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The Office asserted that "Step b did not effectively reflect the use of the multiprocessor computer as step b currently claims each agent can be assigned to one (and only one) processor."

Step b recites "assigning each agent to at least one processor in the multiprocessor computer". In such an assignment, each agent is **assigned to one or more processors**, but is not limited by the claim wording to only one processor. Even if a specific agent is assigned to a single processor, other agents in the plurality of agents can be assigned to other processors to effectively use the multiple-processor computer.

Responsive to the Office's concern, Applicants have amended Claim 10 to make more clear that each *processing element* in steps e) and f) is a *processor* in the multiprocessor computer in step b), and consequently **effectively reflects the use of the multiprocessor computer.** Accordingly, Applicants submit that Claim 10 is clear, as amended, and that the rejection of Claim 10 under 35 U.S.C. § 112 has been overcome.

Accordingly, Applicants submit that amended Claim 10 is now in condition for allowance.

New Apparatus Claim 16 with Dependent Claim 17 for Agent Learning

New apparatus Claim 16 is directed to a multiprocessor computer, a specific computer with specific physical structure. Claim 16 introduces no new matter; it recites hardware limits, described or inherent, in the original specification and claims.

New apparatus Claim 16 recites a specific multiprocessor computer and therefore is statutory subject matter. New Claim 16 does not encompass <u>any and every</u> machine for performing the underlying process. "If a claim defines a useful machine ... by identifying the physical structure of the machine ... in terms of its hardware or hardware and software combination, it defines a statutory product." *See* MPEP § 2106, Section IV.B.2(a). Claim 16 recites a **specific physical structure**: multiple processing units, each having intraprocessor message communication, interprocessor communication resources to share information with other processing units in the computer, data and software storage that is independently accessible to each processor, each processor having the capability to process its assigned agents in parallel with other processors in the computer, and means for controlling the operation of the plurality of processors. *See* Specification, page 5, lines 23-26; and page 6, lines 5-8. Accordingly, Claim 16 recites an apparatus and is statutory subject matter.

Further, the apparatus of Claim 16 is limited to a practical application -- predicting a change in an economy. Accordingly, the process practiced by the apparatus of Claim 16 is also statutory subject matter.

Claim 17 depends from and further defines Claim 16 and adds the capability for agent learning -- which can simulate decision makers in a real economy -- as recited in original Claims 3 and 11. *See* Application, page 10, lines 15-18. Accordingly, Applicants submit that Claims 16 and 17 are in condition for allowance.

New Claim 18 is Limited to a Second Practical Application

New Claim 18 is a claim directed to the method of predicting a change limited to a practical application of a non-monetary economy. Applicants' invention acts with a model of a military confrontation economy -- representing military capabilities, campaign strategies, and battlefield communications. The present invention predicts behavior of non-monetary economy models that are too complex to solve without the present invention. Claim 18 is

limited to a second practical application in the technological arts and contains no new matter. *See* Specification, page 10, lines 10-13; page 3, line 26; and Claim 1.

Accordingly, Applicants submit that Claim 18 is in condition for allowance.

New Claim 19 with Agent Learning and Practiced on a Computer

Agent learning can be simulated for decision makers in a real economy. *See* Specification, page 10, lines 15-17. Claim 19 adds the limitation to practice on a computer comprising a plurality of processing units to original Claim 3. Applicants submit that a method of using a multiprocessor computer to predict behavior of an economy is a practical application in the technological arts, and that Claim 19 is accordingly in condition for allowance.

Conclusion

Applicants have responded to each and every requirement and urge that the Claims as presented are now in condition for allowance. Applicants request expeditious processing to issuance.

Respectfully submitted,

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CERTIFICATION UNDER 37 CFR 1.8

I hereby certify that this correspondence and documents referred to herein were deposited with the United States Postal Service as first class mail addressed to: Assistant Commissioner for Patents, Washington, DC 20231 on the date shown below.

Date: 4/19/99 By: V. Gerald Grafe